STANDARDS DEVELOPMENT BRANCH OMOE
36936000010295

WATER RESOURCES AND ITS MANAGEMENT

BACKGROUND DOSSIER

TD
390
.W38
MOE

RIO WATER RESOURCES COMMISSION

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at copyright@ontario.ca

TD
390
.W38
Water resources and its management : background dossier.
80548

WATER RESOURCES AND ITS MANAGEMENT

BACKGROUND DOSSIER

ONTARIO WATER RESOURCES COMMISSION

INTRODUCTION:

Management of our water involves many sciences, all of which are correlated into a pattern of effort designed to evaluate, assess and plan for the use, protection and inventory of our water resources. This is being done to meet current and future needs and the demands of individuals, municipalities, industries, agriculturalists and the aquatic environment.

Many considerations are involved in the management program such as waste input, nutrient build-up, flow, precipitation, silt sedimentation, aquatic growth, forestation, runoff, soil erosion, and most important of all, the use to be made of the waters. It is impractical to attempt to explain the many varied areas of scientific and technical involvement. What has been attempted in this review of major areas of consideration and activity is to convey grossly condensed highlights of some of the important aspects relating to our environment, our basic water problems and finally to relate this material to the water management program.

WATER IN ONTARIO

The total area of Ontario is 412,582 square miles, of which it is estimated 68,490 square miles or 17 per cent is lakes and rivers.

There are an estimated 2,362 miles of fresh water and 680 miles of salt water shoreline of important bodies of water within the province. The Great Lakes - St. Lawrence waterway constitute a large part of the surveyed fresh water shoreline.

The Great Lakes is one of the most important inland waterways in the world, and one of Ontario's greatest assets. The total drainage area of these lakes is 295,200 square miles, of which 122,040 square miles lies within the borders of Ontario. The attached table gives some pertinent information regarding these lakes.

Ontario has an abundant supply of inland lakes and rivers, with most of the largest being located in northern Ontario. The largest of the northern rivers is the Albany system which has a drainage area of 52,300 square miles. In all, the northern rivers draining into Hudson Bay cover an area of 271,342 square miles. This constitutes about 66 per cent of the entire area of the province.

The largest river system in southern Ontario is the Ottawa River (Ontario - Quebec border) which has a drainage area of 19,200 square miles. The second largest is the Trent system which has a drainage area of approximately 4,700 square miles, and the third is the Grand River system which drains 2,614 square miles.

Of the land surface within the province draining to the Atlantic Ocean, the Great Lakes - St. Lawrence land surface accounts for the drainage of 87,820 square miles, and that of the Ottawa River, 19,200 square miles. The Great Lakes water surface accounts for another 34,220 square miles.

GREAT LAKES DATA

Lake	Length Miles	Width Miles	Depth Feet	Surface Area Total Sq. Miles	Surface Area Ontario Sq. Miles	Drainage Area Total Sq. Miles	Drainage Area Ontario Sq. Miles
Superior	383	160	1,302	31,820	11,110	80,000	43,330
Michigan	321	118	923	22,400	0	67,860	0
Huron	247	101	750	23,010	13,900	72,620	47,570
St. Clair	26	24	23	490	280	7,430	4,110
Erie	241	57	210	9,930	4,950	32,490	11,110
Ontario	193	53	778	7,520	3,980	34,800	15,920

The average annual precipitation is approximately 28 inches in northern Ontario and 33 inches in Southern Ontario. It varies from 18 inches along the Ontario-Manitoba border to about 40 inches at various locations in the lee of the Great Lakes.

In terms of gallons, precipitation of 30 inches annually over the 412,582 square miles of the province amounts to approximately 180,000 billion gallons or 1,200,000 gallons per day per square mile. However, making allowance for evaporation and transpiration losses, which can account for as much as 60 per cent, and other complicated hydrologic and geologic factors, the estimated total amount of fresh water available for use by man annually in Ontario is reduced to 94 billion gallons per day or approximately 15,000 gallons per day for each person.

GROUND WATER

Ground water is that which occurs below the surface of the ground in the zone of saturation, where all pore spaces and fractures are filled with water. The surface of the saturated zone, which may be close to or far below the land surface, is called the water table. A formation which will hold, transmit and yield ground water in usable quantities is known as an aquifer.

It is estimated that half of the water available to man through precipitation enters the ground water system. In sandy areas the rate of infiltration is higher than in clay areas and the amount of water entering the aquifer is greater. The amount and intensity of rainfall, the nature of soil and vegetation, the slope of land surface, and wind and temperature conditions all play a part in governing the amount of water entering the underground system.

The amount of water which can be removed in any specific area depends on the character of the aquifer and the amount of recharge. Fine-grained materials such as clay or silt, have high porosities and abilities to hold large quantities of water in storage but water has a hard time passing through them and this feature makes them a poor source of supply. Coarse sediments such as coarse sands and gravels pass water through easily and are usually good sources of water supply.

A great deal is still to be learned about our water resources and includes such things as qualify and quantity variations and the relationships between the various hydrologic factors affecting our waterways.

Water Use:

Some 30 per cent of Ontario's population is dependent on individual ground and surface water systems. These are located for the most part, in rural areas of the province.

The average rural homeowner uses approximately 50 gallons of water daily and it has been estimated that rural needs, apart from irrigation, collectively amount to approximately 100 million gallons per day.

Water used for irrigation, which is considered to be a consumptive use because an estimated 65 to 95 per cent is not available for re-use, has been estimated at approximately two billion gallons a day during the irrigation season.

Urban domestic, commercial and municipally-supplied industry uses a steadily increasing amount of water. In 1966, some 600 communities in Ontario were served by municipal waterworks systems which supplied an estimated 800 million gallons of water daily. Approximately 60 per cent of the water supplied by municipal systems was drawn from the Great Lakes - St. Lawrence system, with about 20 per cent from ground water sources and 20 per cent from inland surface water.

A community with little or no industry has an average per person comsumption of from 50 to 60 gallons of water daily. This will increase to around 100 gallons per day with a moderate amount of lawn watering and industrial use, and may exceed 200 gallons per day if considerable water is supplied to industry through the waterworks system.

The heaviest demands on our water resources are made by industry. Studies have indicated that private industrial water use varies from five to ten times higher than that supplied by municipal systems. The amount used by private industry from their own ground or surface water sources is estimated at four billion gallons daily. This estimate does not include water used for the generation of electricity.

In all, the present industrial, agricultural and municipal withdrawal of water for all purposes amounts to approximately seven billion gallons per day. This is only a small portion of the 94 billion gallons per day theoretically available. However, the remoteness of much of this available water from many areas of the province where it is required reduced this figure in relation to any specific area, sometimes to the point of shortages.

HISTORICAL CONSIDERATIONS

In order to generalize the effect of growth on a watershed, it would help to historically recount some of the important aspects which have a bearing on this development.

In early pioneer days a nameless watershed formed a river flowing through a bountiful forest which in turn discharged into a clear lake. The area was populated by the occasional Indian village.

As settlement began, land was cleared of forest and became farms. Eventually communities began to develop which cut farther into forests not only for the townsite but for the timber to construct dwellings.

Over the years the forest cover was gradually reduced to feed the needs of a growing population. Swamp and marsh areas were drained to accommodate the rising need for more farmland.

The growing settlement's demand for water grew. Hundreds then thousands of wells were dug. And, the lake and river and its tributaries began to take the wastes from this development in ever increasing volumes.

Finally industry began to develop in the area and added its own share to the needs for water, land and places to dispose of process wastes.

The overall effects of this development went unnoticed when the population was small. But, as the population increased and spread throughout the watershed, and the established communities began to grow in size with the development of industry, the overall effects slowly began to become apparent.

Marshland, which was once used to recharge ground water aquifers, was cultivated and not only reduced the amount of rainfall able to enter the aquifer but increased the amount of runoff.

Forest cover now removed could no longer retain water required by the ground and caused further runoff; much of which carried away valuable topsoil.

During periods of heavy rain or rapid melting of snow, surface waterways flooded and inundated communities and homes along the banks, eroding the banks of the river itself, as the river was unable to handle the ever increasing amounts of runoff. Lake levels fluctuated violently.

Community, industrial and agricultural wastes began to change or destroy the aquatic life in the lake and river and the banks of both became unsightly, giving off offensive odours.

Ground water levels dropped and during periods of dry weather the rivers' flow decreased to nearly a trickle. The effects of continuous neglect were now more than obvious. Lack of a proper water management program for the development of the area had left its mark.

EUTROPHICATION AND POLLUTION

Lakes, as with any impounded waters, age gradually. Young natural lakes are generally relatively barren bodies of cold water. The ageing process proceeds as natural drainage from forest and plain add nutrients and bottom sediments which lead to an increase in biological productivity. The surface sources and the natural exchange from lake sediments contribute carbon, phosphorus and nitrogen which are considered to be the major growth-stimulating plant nutrients.

These changes occur in the surface and deep waters of the lake. Thus it passes gradually from a nutrient-poor to a nutrient-rich state, with resulting increased growths of aquatic plants and animals. Fish species change. This process of ageing with nutrient enrichment is called eutrophication.

As living matter increases and deposits pile up on the bottom, a lake becomes smaller and shallower, its waters become warmer, plants take root on the bottom and gradually take up more space, and their remains accelerate the filling of the basin. Eventually the lake becomes a marsh, is overrun by vegetation from the surrounding area and gradually disappears.

The natural processes are so slow that the lifetime of a lake may span geological eras. Its rate of ageing will depend on physical and geographic factors such as the initial size of the lake, the mineral content of the basin, the climate of the region and the extent of man's encroachment.

The activities of man in altering the landscape with agricultural development, urbanization and industrial growth increases the nutrient input and sediments, which can accelerate the ageing process.

Eutrophication and pollution are not synonomous. A body of water may become increasingly biologically active owing to certain kinds of pollution; however, all pollution is not eutrophication. For example, the discharge of arsenics, acids or copper compounds cause pollution, but do not lead to any enrichment, and if in heavy enough concentration would have drastic effects upon the aquatic environment. On the other hand phosphates and nitrates contained in waste discharges would enrich the water's environment and promote further biological activity.

Accelerated eutrophication of lakes and streams is one of the major problems to be resolved in preparing plans for the overall water management program.

WATER POLLUTION

To pollute means to destroy the purity of, make foul or filthy; therefore, water pollution means the destruction of the purity of water by impairing its quality to a point where it becomes unfit for the many uses for which it is intended.

Human wastes, industrial wastes, farm animal wastes, pesticides, herbicides, and garbage of any kind are pollutants. Any measureable quantity of any of these pollutants in a waterway is pollution.

Water pollution endangers health, robs us of our commercial and sport fishing, destroys our recreational areas, reduces property values by impairing the appearance and usefulness of land and buildings, affects the quality of drinking water supplies and makes it costly to treat, damages bridges, docks and boat hulls, and destroys wildlife.

Pollution may cause water to become foul, septic and unsightly with strong odours being given off, or it may deplete the oxygen content of the water to a point where fish and other aquatic life can barely exist or are destroyed.

Today we know from the discoveries of Pasteur, Koch and Lister the dangers that may lurk in even clear, odourless water. We are protected from the dangers of typhoid fever, endemic diarrhea, dysentry and related diseases of the environment by medical science. However, because we have been fortunate in having few outbreaks of water-borne disease does not mean we are free from further danger for pollution could become a potent source of infection at any time.

Domestic Wastes

We all contribute to and are responsible for water pollution. Waste water is the product of our environment to which little notice has been taken once it leaves the confines of our homes, farms or commercial establishments.

The wastes produced in our homes--from toilets, bath water, dish water and laundering--along with wastes from hotels, restaurants, hospitals and other commercial establishments serving our needs, are called domestic wastes. These wastes are our personal contribution to our water pollution problems.

Fortunately these wastes are not as much of a problem today as they were twenty years ago. Pollution control plants have provided the means of treating these types of wastes effectively.

Industrial Wastes

Industry produces millions of tons of wastes daily through manufacturing processes. These consist of such things as blood, grease, oil, bark, phenols, and chemicals of all kinds. The list of waste materials produced is extensive. And, as new products are introduced, new waste material production problems will be a by-product of this development.

The pulp and paper, aluminum, steel, plastic, oil and allied chemical industries are giants of the industrial world in terms of water used and waste material production. Many have or are programmed to have waste control facilities. Many have highly specialized problems in recovery or removal of waste materials from process waste water which will require research to resolve. However, for the most part, industry in the province has assumed its responsibilities for pollution abatement.

Agricultural Wastes

Farms can contribute to water pollution problems through mishandling of animal wastes, improper soil fertilization and crop irrigation, and through the unwise use of pesticides. All or any of these factors could lead to the contamination of the ground or surface water supplies.

The farm animal population in Ontario produces an amount of waste equivalent to that from 45 million people. An enterprise producing annually at a rate of 50,000 laying hens, or 5,000 market hogs, or 1,000 beef cattle, or 500 dairy cattle, generates a waste disposal problem comparable to a city of 10,000 persons.

The importance of managing these wastes to prevent contamination of water resources is apparent.

It is just as imperative for agriculturalists to provide safeguards through proper farm practices as it is for industry and the community to provide for proper treatment.

Other Considerations

Waste material breakdown in our waterways has produced other problems. The growth of excessive algae and weeds along the shores of lakes and rivers, and changing fish populations are major considerations.

The waste matter breakdown has produced an excessive amount of nutrients in the water which support the nuisance growth of algae and weeds. These breakdown products can affect the food chain which govern the species of fish our water will maintain.

When algae breaks away from the bottom of a lake and washes ashore, it creates another problem. It rots and creates offensive odours and unsightly conditions, which in turn reduces the recreational value of many beach areas during the height of the summer season.

The nutrient problem is being actively investigated and much research has been and will continue to be done into the ways and means of controlling and/or utilizing the excessive growth of algae and weeds, and into ways of assisting nature in the food chain to promote the growth and abundance of desirable fish species.

Another problem, not related to organic pollution but just as serious in its own way, is the formation of silt deposits as a result of soil erosion. These deposits block waterways and require the maintenance of costly systems to clear ponds, reservoirs and harbours. Good land practices will provide control of this undesirable condition.

THE ECONOMICS OF CLEAN WATER

It is unrealistic to picture all the lakes, rivers and streams within the province being returned to their original quality before the encroachment of man. The cost would be beyond our means.

In unsettled areas, far from the influence of man, the smallest rills and brooks pick up impurities and nutrients from precipitation and the channels through which they flow. These are passed on to the interconnecting streams and rivers, which add their share, to eventually be discharged to a lake or the sea. This is the natural evolutionary process at work.

When man encroaches on these waterways he discharges his treated and untreated wastewater and adds to the impurity and nutrient load, sometimes in excess of the waterways ability to assimilate these loadings.

Man's encroachment is inevitable, his use of water a necessity, but in order to utilize water to the best advantage he must evaluate and establish desirable objectives for the recovery or maintenance of the water he needs to protect it for further use.

How clean any particular river or lake must be will depend primarily upon the uses to be made of the waters.

Waters used for recreational purposes in which human contact is made, such as swimming and water skiing, demand very high quality standards for the protection of human health. Tourism, one of our major industries, relies upon our water resources to provide the environment conducive to the needs of tourists. Without the thousands of lakes and rivers in our resort areas being maintained at reasonable water quality levels, we would lose the desirable economic benefits and revenues tourism brings into the province.

The quality of water to be used for a municipal water supply source will dictate the cost of treatment. The poorer the quality of the source the more expensive the treatment required and the higher the unit cost to the consumer.

Water used by industry must be of reasonable good quality for such uses as bleaching of cloth, dyeing, preparation of foods, and even for cooling systems which would deteriorate with undesirable impurities. When industrial water treatment is required before use, this cost is reflected in the cost of the products produced by the industry. Generally, industrial water must be of good quality and, in heavy use industries, available in large quantities.

Agriculture requires good quality water for livestock production and crop irrigation. This is particularly important with vegetable crops which can be eaten raw. Unlike municipalities, agriculturalists cannot afford the expense of individual treatment systems and must rely upon good quality source water.

All these considerations, and many more, have a bearing on the establishment of any water quality standard, and on the economics of clean water.

WATER MANAGEMENT AND WATERCARE

In order to evaluate and establish water quality standards or objectives for any particular watershed, lake, river or stream, it is necessary to study many factors relating to the area involved.

Prime considerations are the water supply requirements of agriculturalists, industries, communities and individuals in the area; current and contemplated future water needs of the area; the quality and quantity of surface and ground water available; current and future wastewater disposal requirements, particularly relating to effluent dilution; the natural ability of the waters to assimilate wastes; soil conditions of land bordering the waters; and recreational needs if required or desirable.

Relating to these considerations, water resources surveys (surface and ground) are carried out to inventory available water supplies and uses. Water quality surveys are carried out to evaluate water quality, find pollution sources and to ascertain current use of the waters. Biological surveys are carried out to evaluate the biota of the waters and to study the effects of man's encroachment.

On the basis of accumulated data from the various surveys, recommendations can be made to the concerned parties for the elimination of pollution sources, the future supply potential of area reserves can be evaluated and related to area uses, and standards can be set for the protection and maintenance of the water's quality.

In the industrial waste area, OWRC staff maintain a quality and quantity inventory of industrial waste disposal; investigate, on a regular basis, all industrial sources of pollution and prepare engineering reports which form the basis for obtaining compliance with the terms of the OWRC Act for pollution control; assist municipalities and industries in waste control through advisory appraisal of new-industry locations or expansion of existing plants; review engineering plans for the collection, treatment, transmission and disposal of wastes from industrial operations and prepare certificates of approval as required by the OWRC Act; appraise difficult waste treatment problems; and carry out detailed industrial studies.

In the domestic or community area, OWRC staff evaluate plans for, inspect, promote and supervise all the water supply and waste treatment plants throughout the province; conduct training courses for plant operators; monitor water quality; study and control pollution; supervise plumbing; control pollution from water craft; and plan for regional water supply and waste treatment facilities.

In the water inventory and supply area, OWRC staff carry out drainage and river basin surveys; test-drilling and well-construction projects; hydrologic studies and hydrogeologic surveys; licence and supervise the operation of all provincial water-well contractors; and issue water-taking permits for users taking more than 10,000 gallons per day. Data accumulated from the various surveys and studies assists industries, agriculturalists, communities and individuals with water supply problems.

A variety of other duties are carried out by staff and include; technical and scientific investigations of theory and procedures necessary to provide information on the aquatic environment and on the collection, production, transmission, treatment, storage, supply, and distribution of water and wastewater; develop supervised construction, operate and train staff for all OWRC - built water supply and waste treatment plants; carry out biological, bacteriological and chemical studies and surveys; and analyse samples relating to all water management programs.

The increased pressures on our water supplies have necessitated the manipulation of our aquatic resources to satisfy the multifaceted interests of our society. Considering its major uses, a body of water can be managed with the aid of mechanical or chemical control. Generally, these control measures would be confined to the nuisance areas and should not seriously disrupt the ecology of the resources. Chemical products are now available which are useful in controlling aquatic nuisances such as excessive aquatic vegetation and algae, leeches, swimmers' itch, undesirable coarse fish species, and the larval stages of such insect pests as mosquitoes and blackflies which exist in water. OWRC evaluations of chemicals approved for such purposes have demonstrated their safety to non-target organisms, rapid breakdown to innocuous end-products and the safety of treated water for domestic consumption, irrigation and other recognized uses.

Many of the programs are carried out in conjunction with other provincial and federal government departments. The extensive Great Lakes program, which involved a large number of staff specialists, was carried out under the auspices of the International Joint Commission.

Although the OWRC is charged with the responsibility for managing the water resources of the province, the ultimate success of its programs rests in the co-operation of each and every citizen. In this regard watercare is required to maintain the beauty and productivity of our water resources for this and generations to come. Lack of watercare will impede this province's opportunity for growth and development.

FOR FURTHER INFORMATION CONTACT:

Ontario Water Resources Commission,
Division of Public Relations and Information,
135 St. Clair Avenue West,
Toronto 195, Ontario.